School of Data and Computer Science, Sun Yat-sen University

T02 CSP and KRR

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1 Q1

1. (a) 变量：$V_{11}, V_{12}, V_{13}, V_{21}, V_{22}, V_{23}, V_{31}, V_{32}, V_{33}$

   (b) 值域：$Dom[V_{ij}] = \{1-9\}, 1 <= i <= 3, 1 <= j <= 3$

   (c) 约束：

$$\sum_{i=1}^{3} V_{1i} = \sum_{i=1}^{3} V_{2i} = \sum_{i=1}^{3} V_{1i} = k$$

$$\sum_{i=1}^{3} V_{i1} = \sum_{i=1}^{3} V_{i2} = \sum_{i=1}^{3} V_{i3} = k$$

$$\sum_{i=1}^{3} V_{ii} = \sum_{i=1}^{3} V_{i(4-i)} = k$$

2. (a) 变量：$Visited_1, Visited_2, \cdots, Visited_n$

   (b) 值域：$Dom[Visited_i] = \{City_1, City_2, \cdots, City_n\}, 1 <= i <= n$

   (c) 约束：

$$All - Diff\{Visited_i\}, 1 <= i <= n$$

$$Visited_i \ is \ conected \ to \ Visited_{i+1}, 1 <= i <= n-1$$

3. (a) 变量：I, N, T, L, A

   (b) 值域：

$$Dom[I] = \{1-9\}$$

$$Dom[N] = \{1-9\}$$

$$Dom[T] = \{1-9\}$$

$$Dom[L] = \{1-9\}$$

$$Dom[A] = \{1-9\}$$

   (c) 约束：

$$All - Diff\{I, N, T, L, A\}$$

$$(T * L)\%10 = I$$

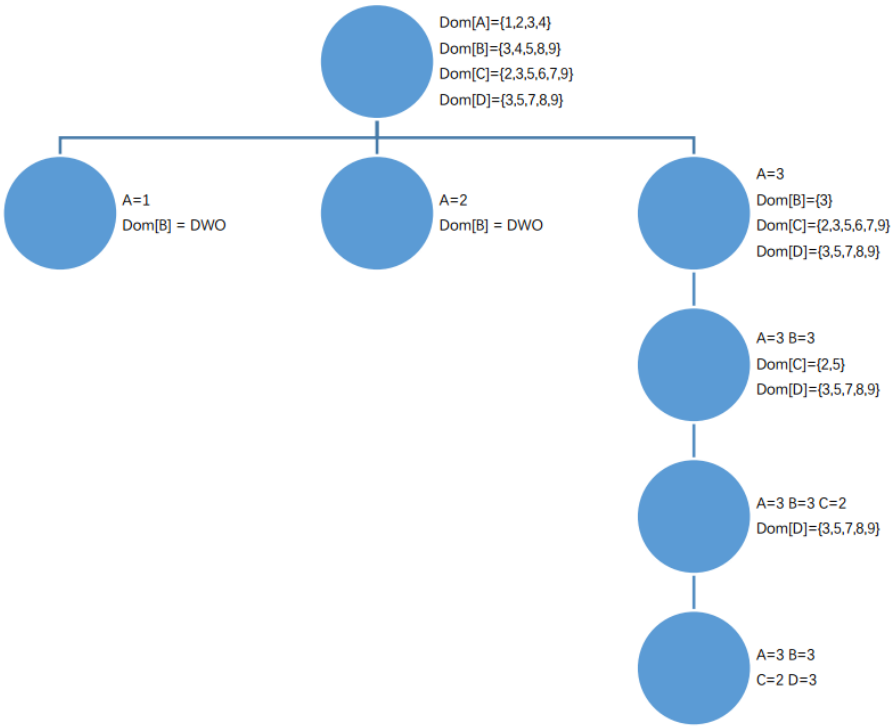
$$[(T * L)/10 + N * L]\%10 = A$$

$$\{[(T * L)/10 + N * L]/10 + I * L\}\%10 = A$$

$$\{[(T * L)/10 + N * L]/10 + I * L\}/10 = A$$

2 Q2

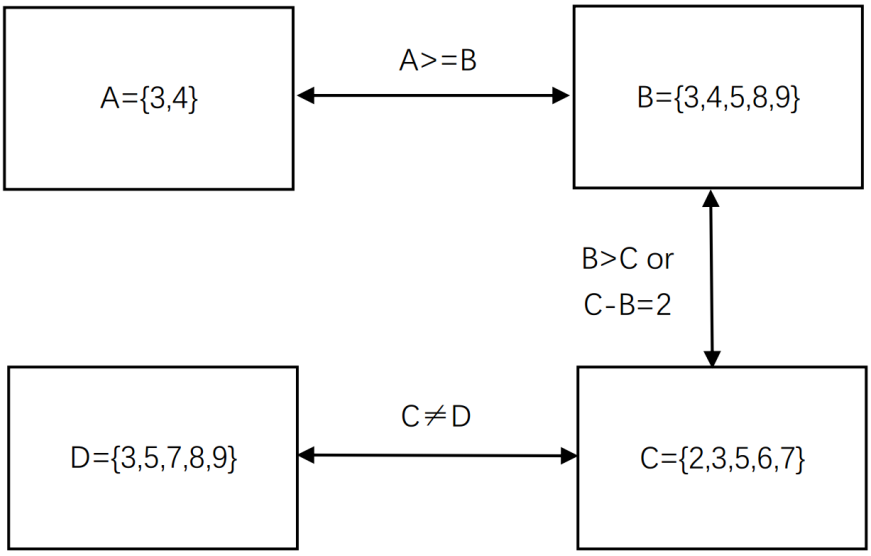
(a)



(b) 对初始值域运用GAC：

$A >= B$ remove $A = 1, A = 2$

$B > C$ or $C - B = 2$ remove $C = 9$



对处理后的值域运用GAC：

(1) $A = 3$

$B = \{3\}$ $A >= B$ remove $B = 4, 5, 8, 9$

$C = \{2, 5\}$ $B > C$ or $C - B = 2$ remove $C = 3, 6, 7, 9$

$D = \{3, 5, 7, 8, 9\}$

(2) $A = 3, B = 3$

$C = \{2, 5\}$

$D = \{3, 5, 7, 8, 9\}$

(3) $A = 3, B = 3, C = 2$

$D = \{3, 5, 7, 8, 9\}$

(4) $A = 3, B = 3, C = 2, D = 3$

3 Q3

由题意知：

- $S1 : \forall x \forall y(\neg P(x, y) \vee P(y, x))$
- $S2 : \forall x \forall y \forall z(\neg P(x, y) \vee \neg P(y, z) \vee P(x, z))$
- $S3 : \forall x(P(x, g(x)))$
- $\neg(\forall x P(x, x)) = \exists x \neg P(x, x)$

即：

(1) $\neg P(x, y), P(y, x)$

(2) $\neg P(x, y), \neg P(y, z), P(x, z)$

(3) $P(x, g(x))$

(4) $\neg P(a, a)$

(5) $R[1b, 2b]$ $x = z$ $(\neg P(x, y), P(z, z))$

(6) $R[5a, 3b]$ $y = g(x)$ $P(z, z)$

(7) $R[4, 6]$ $z = a$ $\{\}$

故：$S1 \wedge S2 \wedge S3 \supset \forall x P(x, x)$

4 Q4

- 由题意知：
  - $A: friend(P,B) \wedge hate(M,B)$
  - $P: \neg scene(P) \wedge \neg friend(P,B) \wedge \neg hate(P,B)$
  - $M: scene(A) \wedge scene(P)$
  - $murder(A) \rightarrow \neg murder(P) \wedge \neg murder(M)$
  - $murder(P) \rightarrow \neg murder(A) \wedge \neg murder(M)$
  - $murder(M) \rightarrow \neg murder(A) \wedge \neg murder(P)$
  - $\forall x\ murder(x) \rightarrow scene(x)$
  - $\forall x\ murder(x) \rightarrow hate(x,B)$
  - $\forall x \forall y\ friend(x,y) \rightarrow \neg hate(x,y)$

  即：

  $(1)(murder(A), friend(P,B))$

  $(2)(murder(A), hate(M,B))$

  $(3)(murder(P), \neg scene(P))$

  $(4)(murder(P), \neg friend(P,B)$

  $(5)(murder(P), \neg(P,B))$

  $(6)(murder(M), scene(A))$

  $(7)(murder(M), scene(P))$

  $(8)(\neg murder(A), \neg murder(P))$

  $(9)(\neg murder(A), \neg murder(M))$

  $(10)(\neg murder(P), \neg murder(M))$

  $(11)(\neg murder(x), scene(x))$

  $(12)(\neg murder(x), hate(x,B))$

  $(13)(\neg friend(x,y), \neg hate(x,y))$

  a 如果A是凶手：

  $(14)(\neg murder(A), murder(P), murder(M))$

(15)$R[10,14]$ $(\neg murder(A))$

无法归结出空集，假设不成立。

b 如果P是凶手：

(14)$(\neg murder(P), murder(A), murder(M))$

(15)$R[9,14]$ $(\neg murder(P))$

(16)$R[11,15]$ $x = P$ $(\neg murder(P), scene(P))$

(17)$[16,3]$ {}

可归结出空集，假设成立，P为凶手。

c 如果M是凶手：

(14)$(\neg murder(M), murder(P), murder(A))$

(15)$R[8,14]$ $(\neg murder(M))$

无法归结出空集，假设不成立。

- 当凶手不止一人时：

(1) 假设A、M为凶手，则A、M说的话为假，B说的话为真，则hate(M,B)为假，scene(A),scene(P)为假，A、P有不在场证据，M没有杀人动机，三人都不是凶手。

(2) 假设A、P为凶手，则A、P说的话为假，M说的话为真:

[1]$(murder(A), friend(P,B))$

[2]$(murder(A), hate(M,B))$

[3]$(murder(P), \neg scene(P))$

[4]$(murder(P), \neg friend(P,B)$

[5]$(murder(P), \neg(P,B))$

[6]$(murder(M), scene(A))$

[7]$(murder(M), scene(P))$

[8]$(murder(A), murder(P), murder(M))$

[9]$(\neg murder(x), scene(x))$

[10]$(\neg murder(x), hate(x,B))$

[11]$(\neg friend(x,y), \neg hate(x,y))$

[12]$(\neg murder(A), \neg murder(P), murder(M))$

[13]$R[8,12]$ $murder(M)$

无法归结出空集，假设不成立。

(3) 假设P、M为凶手，则P、M说的话为假，A说的话为真:

[1]$(murder(A), friend(P, B))$

[2]$(murder(A), hate(M, B))$

[3]$(murder(P), \neg scene(P))$

[4]$(murder(P), \neg friend(P, B)$

[5]$(murder(P), \neg(P, B))$

[6]$(murder(M), scene(A))$

[7]$(murder(M), scene(P))$

[8]$(murder(A), murder(P), murder(M))$

[9]$(\neg murder(x), scene(x))$

[10]$(\neg murder(x), hate(x, B))$

[11]$(\neg friend(x, y), \neg hate(x, y))$

[12]$(\neg murder(P), \neg murder(M), murder(A))$

[13]$R[8, 12]\ murder(A)$

无法归结出空集，假设不成立。